

ABSTRACT

An amorphous carbon film is provided with a density of $2.8 - 3.3 \text{ g/cm}^3$. It would be preferable for the film to have: a spin density of $1 \times 10^{18} - 1 \times 10^{21}$ spins/cm³; a carbon concentration of at least 99.5 atomic percentage; a hydrogen concentration of no more than 0.5 atomic percentage; an inert gas element concentration of no more than 0.5 atomic percentage; and a Knoop hardness of 3000 - 7000. A mixed layer with a thickness of at least 0.5 nm and no more than 10 nm is formed from a parent material and at least material selected from: B, Al, Ti, V, Cr, Zr, Nb, Mo, Hf, Ta, and W. An amorphous carbon film is disposed on the mixed layer or a metallic intermediate layer formed on the mixed layer, thereby increasing adhesion. This amorphous carbon film is formed with solid carbon using sputtering, cathode-arc ion plating, or laser abrasion.